REMARKS

Claims 1-22, 24-30 and 32-40 are pending in this application. Claims 1, 26 and 32 have been amended to specify that the porous low-k dielectric material is annealed and claims 22 and 31 have been amended to specify that the annealing and silanol capping processes are performed simultaneously. These amendments are supported throughout the specification, e.g., at page 9 lines 21-30. Claims 24 and 25 have been amended to depend from claim 1.

Claims 1-37 are rejected under 35 U.S.C. 103(s) as being unpatentable under 35 U.S.C. § 103(a) over Birnbaum et al. U.S. Patent No. 6,548,113 ("Birnbaum") in view of Lukas et al. U.S. Patent Application Publication No. US 2004/0096672 ("Lukas") or Gallagher et al. U.S. Patent Application Publication No 2002/023240 ("Gallagher").[1] The Examiner is respectfully requested to reconsider all rejections in light of the amendments and following remarks.

Claim 1 relates to a process to prepare a low-k dielectric film. The process involves forming a precursor film on the substrate, the precursor film comprising a porogen and a structure former; exposing the precursor film to ultraviolet radiation to facilitate removing the porogen from the precursor film and thereby create voids within the dielectric material to form the porous low-k dielectric material; and exposing the porous low-k dielectric material to a silanol capping agent.

Thus, dielectric material is formed from a precursor film having a porogen and a structure former. The prescursor film is exposed to UV radiation to remove the porogen. As explained in the specification and discussed the previous Amendment, the UV-mediated porogen removal process can result in hydroxyl groups (–OH) forming within the dielectric material. When the substrate is exposed to ambient, the hydroxyl groups will interact with moisture and trap water in the dielectric, increasing the dielectric constant. The claimed process addresses this issue by exposing the porous material to a silanol capping agent, thereby replacing the hydroxyl groups with non-polar groups, rendering the film hydrophobic and allowing it to maintain a low overall dielectric constant, even when exposed to ambient moisture. (See page 9, line 31 to page 10, line 12 of the specification)

Although each of the cited references describes certain aspects of the claimed invention, Applicants submit that claimed invention is patentable over the combination of Birnbaum and

[1] Claims 1-22 and 24-39 are listed as being rejected over Birnbaum in view of Gallagher while the explanation of the rejections refers solely to the combination of Birnbaum and Lukas. Applicants address both combinations in this Response.

Lukas (or Birnbaum and Gallagher) at least because the skilled artisan would have no motivation to combine the references in the manner the Examiner suggests.

Birnbaum describes various reactors that may be used for dehydroxylation reactions. Contrary to the Examiner's contention, nowhere does Birnbaum teach or suggest "forming a dielectric layer forming a precursor film on the substrate, the precursor film comprising a porogen and a structure former." Birnbaum does not address formation of the dielectric film at all, teaching only that "[w]afers 22 coated with dielectric are placed between heating elements 20." Thus, while Birnbaum describes dehydroxylation of dielectric film, there is no mention of forming a precursor film having a structure former and a porogen, or of employing UV radiation to remove the porogen.

While Lukas describes various post UV-exposure treatment steps for its porous film at paragraphs [0060] through [0072], there is no mention of silanol capping or the problems of dangling bonds or uncapped hydroxyl groups appears in these paragraphs. Thus, it is respectfully submitted, that the Lukas et al. reference fails to teach or reasonably suggest "exposing the porous low-k dielectric material to a silanol capping agent."

Neither of the references teach or suggest the particular problems of dangling bonds or uncapped hydroxyl groups that UV-mediated porogen removal has on the dielectric film. Without such a teaching, no one of skill in the art would be motivated to combine the UV-mediated porogen removal in Lukas with the dehydroxylation step of Birnbaum.

Gallagher does not cure the deficiencies of either Birnbaum or Lukas. While Gallagher refers to a porogen that may be removed by UV radiation (paragraph [0039]), there is no teaching or suggestion of silanol capping or the problems of dangling bonds or uncapped hydroxyl groups resulting from UV radiation. Gallagher teaches capping the dielectric with a skin containing groups such as silicon dioxide and organic oxides to improve the elastic and thermal conductivity of the dielectric [paragraph 0045]. Unlike the silanol capping step of the present invention, Gallagher teaches a capping the dielectric with relatively hydrophilic groups (e.g., silicon dioxide and organic oxides). Thus, nothing in Gallagher suggests the problems that UV-mediation porogen removal has on the dielectric film, nor treating the film with a silanol capping agent.

Because none of the references teach or suggest the particular effects UV-mediated porogen removal has on the dielectric film, no one of skill in the art would be motivated to combine the references to arrive at the invention as described by independent claim 1.

In addition, Applicants have amended independent claims 1, 26 and 32 to incorporate the limitations of former claims 22 and 31, specifically that the porous dielectric material is

annealed. According to various embodiments, this aspect of the invention may be used to vaporize unwanted components such as water that may have formed on the substrate after porogen removal, to remove less volatile porogen decomposition products and/or to enhance mechanical strength of film.

Neither Birnbaum nor Lukas teach or suggest annealing the porous dielectric film. The Examiner points to paragraphs [0044] and [0071] of Lukas in reference to former claim 31. However, these paragraphs disclose only annealing as a method of creating pores within the film. All other references to annealing within Lukas that Applicants were able to find are in reference to removing pore-formers from the film, e.g, as an alternative to UV radiation. (paragraphs [0006], [0008], [0051] and [0052]). Thus, while Lukas mentions annealing of the porogen-containing film, nothing in Lukas teaches or suggests annealing the porous low-k material after porogen removal.

Applicants believe claim 1 is patentable over the cited art for at least these reasons. Independent claims 26 and 32 are also patentable for at least the reasons given for claim 1. Each of claims 2-22, 24, 25, 27-31, and 33-39 depend from one of claims 1, 26 or 32. Therefore, these claims are patentable over the cited prior art for at least the reasons stated above.

Conclusion:

In light of the foregoing amendments and remarks, Applicants respectfully submit that all pending claims are now in condition for allowance. Thus, Applicants respectfully request a Notice of Allowance from the Examiner. Should any unresolved issues remain, the Examiner is encouraged to contact the undersigned at the telephone number provided below. No fees appear to be necessary for this Amendment. However, if the Commissioner determines that any fee is due, such fee may be charged to deposit account No. 50-0388 (Order No. NOVLP075).

Respectfully submitted,
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